PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :
H04B 5/00, 3/56

A2

(11) International Publication Number: WO 94/24777

(43) International Publication Date: 27 October 1994 (27.10.94)

(21) International Application Number: PCT/GB94/00787

(22) International Filing Date: 14 April 1994 (14.04.94)

(30) Priority Data:

9307801.2	15 April 1993 (15.04.93)	GB
9326026.3	21 December 1993 (21.12.93)	GB

(81) Designated States: AT, AU, BB, BG, BR, BY, CA, CH, CZ, DE, DK, ES, FI, GB, GE, HU, JP, KG, KP, KR, KZ, LK, LU, LV, MD, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SI, SK, TJ, UA, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
Without international search report and to be republished upon receipt of that report.

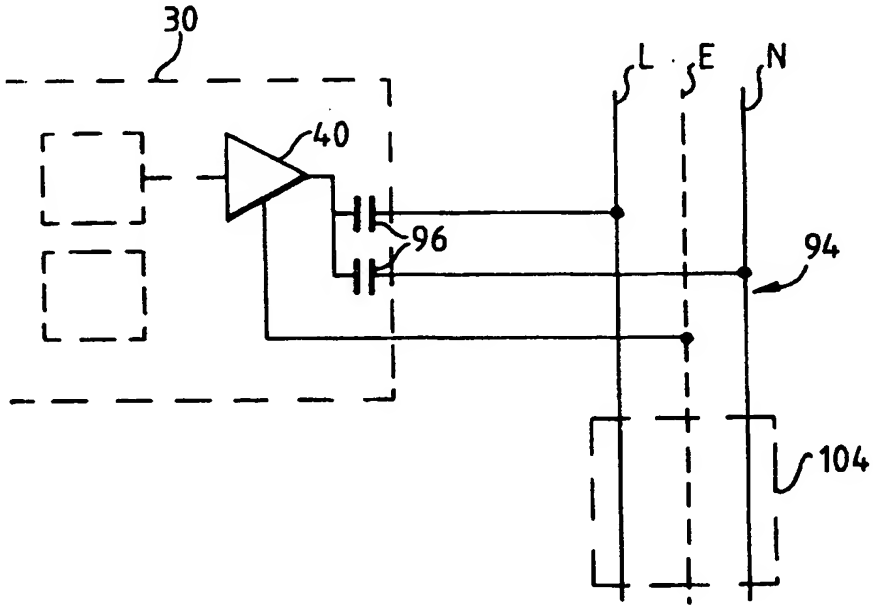
(71)(72) Applicant and Inventor: STAPLETON, Howard, Charles [GB/GB]; Slepe Hall, Ramsey Road, St. Ives, Cambridgeshire PE17 4RB (GB).

(74) Agent: MAGUIRE & CO.; 12 The Broadway, St. Ives, Cambridgeshire PE17 4BN (GB).

(54) Title: DATA TRANSMISSION USING CAPACITIVE COUPLING

(57) Abstract

The specification describes a number of systems each having at least one data sender for injecting a carrier signal into an electrically conductive medium, which signal is modulated by a digital data signal, and one or more data receivers capable of detecting the signal applied to the medium, demodulating that signal and in response to a particular data signal effect a control or information transfer function. Either or both of the data senders and data receivers may be physically coupled to the electrically conductive medium or, capacitively coupled to that medium. The electrically conductive medium may comprise any suitable means - mains electrical cabling or other wiring used in a building, pipework or structural steelwork. Embodiments of the invention provide (Figures 2-4) a paging system; (Figure 5) a two-way communication system; (Figure 6) a hot water radiator heating control system; (Figure 7 and 8) a monitoring system; and (Figure 9) a security system - usable either to monitor the security of an area or the passage of a radio tagged article through an area.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	**GB**	United Kingdom	**MR**	Mauritania
AU	Australia	**GE**	Georgia	**MW**	Malawi
BB	Barbados	**GN**	Guinea	**NE**	Niger
BE	Belgium	**GR**	Greece	**NL**	Netherlands
BF	Burkina Faso	**HU**	Hungary	**NO**	Norway
BG	Bulgaria	**IE**	Ireland	**NZ**	New Zealand
BJ	Benin	**IT**	Italy	**PL**	Poland
BR	Brazil	**JP**	Japan	**PT**	Portugal
BY	Belarus	**KE**	Kenya	**RO**	Romania
CA	Canada	**KG**	Kyrgystan	**RU**	Russian Federation
CF	Central African Republic	**KP**	Democratic People's Republic of Korea	**SD**	Sudan
CG	Congo			**SE**	Sweden
CH	Switzerland	**KR**	Republic of Korea	**SI**	Slovenia
CI	Côte d'Ivoire	**KZ**	Kazakhstan	**SK**	Slovakia
CM	Cameroon	**LI**	Liechtenstein	**SN**	Senegal
CN	China	**LK**	Sri Lanka	**TD**	Chad
CS	Czechoslovakia	**LU**	Luxembourg	**TG**	Togo
CZ	Czech Republic	**LV**	Latvia	**TJ**	Tajikistan
DE	Germany	**MC**	Monaco	**TT**	Trinidad and Tobago
DK	Denmark	**MD**	Republic of Moldova	**UA**	Ukraine
ES	Spain	**MG**	Madagascar	**US**	United States of America
FI	Finland	**ML**	Mali	**UZ**	Uzbekistan
FR	France	**MN**	Mongolia	**VN**	Viet Nam
GA	Gabon				

DATA TRANSMISSION USING CAPACITIVE COUPLING

DESCRIPTION

Technical Field

The invention concerns data transmission and more particularly but not exclusively apparatus for enabling transfer of data by capacitive, reactive coupling of data senders and receivers. That coupling may include use of pre-existing electrically conductive services provided within a building - for example mains electrical cabling.

Background Art

Until now data transmission for information transfer or control functions effective by hardwired links, radio or light wave transmissions, or by use of pre-existing electrical cabling. In its simplest form the closure of a switch in an electrical circuit may enable a lamp to be lit. More complex arrangements making use of a pre-existing electrical cabling have included the use of an arrangement in which a microphone and a loudspeaker are each linked to the cabling, and draw power therefrom, to enable one way communication between the two. Such arrangements are to be found in baby listening intercom systems allowing two-way communications between two physically separated points each of which is linked to and powered by a mains cabling system.

Such arrangements are of limited value in

requiring that the loud speaker and microphones be physically attached to the cabling and draw power therefrom. They will not for example function if the cabling to which they are attached does not carry power.

Again in most arrangements known to us the devices must be coupled to both the line and neutral cores of the cabling to allow them to work and for this reason do not communicate across phases of an electrical power system to a building or a group of buildings.

Furthermore such systems are limited in use to arrangements in which there is a readily available mains cabling layout.

Disclosure of Invention

In one aspect the invention provides a data transfer system comprising at least one data sender electrically coupled or adapted to be coupled to an electrically conductive medium and at least one data receiver, the or each data sender being operable to generate a carrier signal which is modulated by a digital data signal and applied to an electrically conductive medium to which the sender is coupled to generate an electrical capacitive field and the or each data receiver being operable to detect that field, demodulate the signal and in response to the digital data signal effect a control or an information transfer function.

The or each data sender may be electrically coupled to a conductive metal plate, or alternatively be adapted to be coupled to a pre-existing electrically conductive medium.

The or each data receiver may be electrically coupled to an electrically conductive metal detector plate or alternatively be adapted for electrical coupling to a pre-existing electrical conductive medium.

The system may provide a plurality of data receivers, wherein the data sender is operable to modulate said carrier signal with an encoded digital data signal and

wherein each data receiver is operable to receive, demodulate and decode the modulated carrier signal so as to enable the data sender to transmit data to said at least one data receiver.

Desirably, the data sender includes a carrier signal generator and a mixer in which that signal is modulated by a digital data signal from a data signal generator means, the output of the mixer being amplified and passed directly to an electrical conductive medium to which the data sender is coupled.

Advantageously, the or each data receiver includes a detector plate operable to detect a modulated field generated by the electrical conductive medium coupled to the data sender, and wherein the detector plate generates an output signal in response to the detected field which is amplified and compared with a locally generated carrier signal substantially equivalent to the carrier signal generated in the data sender.

Embodiments of the invention provide that the amplified output of the detector plate of the or each data receiver is passed for comparison via a band pass filter.

The carrier signal generated in the or each data receiver may be passed to a phase shifter generating a pair of outputs each equivalent to the carrier wave generated by the data sender but phase shifted relative to one another.

The outputs of the phase shifter of the or each data receiver are preferably fed as inputs to a pair of mixers each receiving the output of the band pass filter, and wherein the outputs of the mixers are passed by low pass filters to a pair of comparators in which they are compared with reference voltages.

The outputs of the comparators of the or each data receiver may be fed to phase detectors in which the digital data applied to the carrier signal in the or each data sender is reconstructed.

With advantage, the output of the phase detectors

in the or each data receiver is fed to a decoder which in response to a particular encoded signal provides an indication of receipt of the encoded signal.

The or each data receiver may be further provided with means allowing the display of information applied to the modulated carrier signal by a data sender.

The system may be implemented as a paging system, wherein there are provided a plurality of data receivers each operable to provide a sensible output indication in response to a particular one of a number of different encoded digital data signals used to modulate the output by the data sender.

In such a system there is preferably provided one data sender and a plurality of data receivers, and the digital data signal from the data sender may be operable to effect operation of some or all of the data receivers simultaneously.

The system may be implemented as a control system, wherein there are provided a plurality of data receivers each operable to effect control of individually associated mechanical device in response to a particular one of a number of different encoded digital data signals used to modulate the output by the data sender.

In such a system there is preferably provided one data sender and a plurality of data receivers, and wherein the digital data signal from the data sender is operable to effect control of some or all of the data receivers simultaneously.

Such a system may be used for controlling operation of a hot water radiator heating system, wherein the electrically conductive medium to which the or each data sender and receiver is coupled is formed by the pipe network of the system, wherein the or each data sender is operable to apply a carrier signal to said pipe network which is modulated by a digital data signal indicative of the temperature required at different locations within the

heating system, and wherein each data receiver is operable in response to a received digital data signal to effect alteration of the setting of a valve associated with a radiator of the heating system.

It may be provided that each data receiver is coupled to a valve driver operable to drive an associated valve open or closed in response to a digital data signal received by the data receiver.

Such a system may be used for controlling operation of a lighting circuit, wherein the electrically conductive medium to which the or each data sender and data receiver is coupled comprising the electrical cabling for powering the lighting and each data sender is operable to apply to that cabling signals effective to control operation light sources at various locations in the lighting system, and wherein each data receiver is associated with a switch operable to control one or more light sources, each data receiver being operable in response to a received digital data signal to open or close its associated switch in the lighting circuit.

The system may be implemented as a monitoring system, comprising in combination at least one first data sender and at least one first data receiver each electrically coupled to the same electrically conductive medium and at locations remote from one another, the or each first data sender generating a carrier signal which is applied to the electrically conductive medium after modulation by digital data signal generated in response to the output of a monitoring device individually associated with the sender, the or each first data receiver being operable to receive the modulated carrier signal, demodulate that signal and in response to the digital data signal generate an output indicative of the location of the sender and the associated monitoring device.

In such a system the or each first data sender is preferably associated with a data receiver and the or each

first data receiver is associated with a data sender, the data sender associated with the or each first data receiver being operable to apply to the electrically conductive medium a modulated carrier wave signal receivable by the data receiver associated with the or each first data sender and which in response thereto enables operation of said at least one first data sender.

The first data receiver may have associated therewith a display enabling a visual indication of the location of a first data sender to apply a modulated carrier wave signal to the electrically conductive medium in response to activation of the associated monitoring device.

The monitoring device associated with the or each first data sender preferably comprises a passive infra red device.

Alternatively, the monitoring device associated with the or each of said first data senders may comprise a receiver operable to monitor the output of a low power transmitter associated with an article moving through an environment, whereby the position of the article within said environment may be monitored by said at least one first data receiver.

The system may be implemented as a communication system and comprise at least one data sender electrically couplable to an electrically conductive medium, at least one data receiver electrically couplable to the electrically conductive medium at a location remote from the data sender, the or each data sender being operable to generate a carrier signal which is modulated by a digital data signal applied to the electrically conductive medium and the or each data receiver being operable to receive the modulated carrier signal, demodulate that signal and in response to a particular data signal enable communication between the data sender and a particular one or more of the data receivers.

In such a system the or each data sender may further include a microphone operable to modulate the carrier wave signal applied to the electrically conductive medium and wherein the or each data receiver includes means for demodulating the detected carrier signal and a loud speaker so that voice communication may be established between the data sender and the data receiver.

Each data sender has a data receiver associated therewith and each data receiver has a data sender associated therewith, so that two way voice communication may be established between remote locations.

The system may be implemented as a security system, wherein the data sender comprises a unit adapted to be worn by an individual and the data receiver unit adapted, in response to a received signal from the data sender, to control operation of a lock enabling access to be made to a facility by an individual wearing the data sender.

Brief Description of Drawings

The above aspects, features and advantages of the present invention will become apparent from the following description of embodiments of the invention made with reference to the accompanying drawings in which:-

Figures 1 and 2, represent highly schematically data transfer systems embodying the present invention,

Figure 3 illustrates a system embodying the invention in block schematic form,

Figures 4A and 4B respectively illustrate the coupling of a sender (such as is provided in the apparatus of Figure 3) to both single phase and three phase power supplies, and

Figures 5 to 9 illustrate highly schematically, other arrangements which embody the invention.

Best Mode for Carrying out the Invention

With reference to the drawings. Figure 1 shows an arrangement which embodies the present invention to

include a data sender 10 electrically coupled to a conductive metal plate 12. The system also includes a data receiver 14 electrically coupled to an electrically conductive detector plate 16 at a position remote from that of the data sender 10. Data sender 10 is operable to apply a signal to the plate 12 associated with it which will be picked up by the plate 16 associated with the data receiver 14, and in response thereto receiver 14 operates an information transfer device indicated generally at 18.

Figure 1 shows a second data receiver 20 coupled to an electrically conductive metal plate 22, which, in response to a received signal from the data sender 10 will effect operation of a device 24 effective to control a function (E.G. close a switch).

Figure 2 illustrates an alternative embodiment of the invention - specifically for use with mains electrical cabling 26.

Parts of the arrangements shown in Figure 2 serving the same function as parts of the arrangement of Figure 1 are given the same reference numeral distinguished by a prime.

In the arrangement of Figure 2. A data sender 10' is coupled to the cabling 26 physically or by electrostatic (e.g. capacitive) means. A data receiver 14' is coupled physically, or capacitively to the cabling 26 at a position remote from that of the data sender 10'. Data sender 12' is operable to directly apply a signal to the cabling 26 which will be picked up by the data receiver 14' which in turn operates the information transfer device at 18'. The second data receiver 20' is shown coupled physically, or capacitively to the cabling 26 and, again, in response to a signal from data sender 12 will cause operation of a device 24' effective to close a switch.

The data senders 12 and 12' may be any device capable of generating a carrier wave signal and modulating that signal with an applied digital data signal and may

include any acceptable form of signal injector and/or microphone and/or alarm indicator and/or keyboard enabling the input of data to the system.

Similarly, the data receiver 14 and 14' may comprise any arrangement of devices operable to receive a signal sent by the data sender to the cabling and to effect an output to an information transfer device 18, 18' or a device 24, 24' controlling a function.

In essence there are two regions of interest in distinguishing why less communication is effected by radiation (that is to say by radio waves) by electric field (i.e. capacitive) or magnetic (i.e. inductive) coupling.

In general terms the region where signal power is received by radio waves is known as the "radiation field region" and the region in which electric or magnetic fields are effective to permit communication is known as the "reactive near field region".

Beyond a distance from a radiating object given by

$$r >= \lambda/2\pi$$

the radiating (e.g. that is to say radio) field predominates and the reactive field components are ineffective.

Within a distance r from a source however defined by

$$r < \lambda/2\pi$$

electric or magnetic field effects predominates.

This distance can be significant as when a radiating frequency of 140.7kHz is selected

$$\lambda = 3x10^8/140.7x10^3 \text{ m}$$

$$\lambda = 2132 \text{ m, and}$$

$$r < 339 \text{ m}$$

Examples of systems embodying the invention include pagers, lighting control circuits and heating control circuits.

If the data senders and data receivers are provided with microphones and loud speakers respectively the system may be used as a public address system or a system allowing voice communication between the data sender location and the location of a particular one of the data receivers.

Each data sender may have in close physical proximity thereto a data receiver and vice-versa allowing two-way communication of data between locations at which the devices are positioned.

Other devices which may be associated with or form part of a data sender include passive infra red detectors operable to monitor the security of an area or smoke or heat detectors to detect the outbreak of fire and the like.

Referring now to Figure 3 which shows in more detail a pager system embodying the present invention.

As shown in the arrangement of Figure 3 the data sender or transmitter 30 includes a clock 34 generating a carrier wave signal at a reference frequency (for example 140.7KHz). The output of clock 34 is fed as an input to modulator 36 in which the carrier wave signal is modulated by the output of a code generator 38. Code generator 38 is one which will produce any one of a predetermined set of "unique" serial data streams when one or more of its associated actuators (switches 38.1 38.2 or 38.3) is closed.

The output of modulator 36 is fed via an output driver amplifier 40 to an electrically conductive metal plate 42, and plate 42 generates a standing wave electrostatic field the pattern of which is set by the modulated carrier wave signal output by the transmitter 30.

The system further includes a data receiver 50 having a detector plate 52 operable to detect the standing wave pattern of plate 42 and to provide an input to a high impedance amplifier 54. The output of amplifier 54 is fed

to a band pass filter 56 (typically having a pass band of 3KHz) the output of which is fed as first inputs to a pair of mixers 58 and 60 as shown. The second inputs to the mixers 58 and 60 are provided from a local clock 62 running nominally at the frequency as the clock 34 in transmitter 30. The output of clock 62 is fed via a phase shifter 64 to provide two inputs - one to each of the mixers 58 and 60 which are 90° phase shifted one from the other.

The outputs of the mixers 58 and 60 are fed through respective amplifiers 66 and 68, low pass filters 70 and 72 and amplifiers 74 and 76 to form first inputs to comparators 78 and 80. The second inputs to the comparators 78 and 80, shown at 82 and 84, respectively are reference voltages.

The outputs of the comparators 78 and 80 are fed to a phase detector 86 operable to provide an output at a logic level "1" if the output of comparator 78 leads that of comparator 80 and a logic level "0" if the output of comparator 78 lags the output of comparator 80.

Thus the operation of the device 86 will be to duplicate the digital data signal used to modulate the carrier wave signal in transmitter 30.

The output of the device 86 is fed to a decoder 88 in which it is compared with a pre-set code and, if a match is found, will cause actuation of a buzzer 90.

It will be appreciated that the signal detected by detector plate 52 and fed via the band pass filter 56 to the mixers 58 is combined in those mixers with phase shifted duplicates of the original carrier signal.

The output of these two mixers are then fed via the low pass filters 70 and 72 which provide a final stage of frequency selection - defining a narrow band of frequencies symmetrically disposed about the carrier wave frequency to which the receiver 50 is operable to respond.

Device 86 is in the form of a quadrature detector monitoring the relative phase of the signals from the

comparators 78 and 80.

In addition to providing a unique code for each of a number of receivers 50 which may be used in the system the data signals applied to the cabling by the transmitter 30 may incorporate information which could be displayed by a receiver 50 provided with an appropriate (e.g. an LCD driver and display as indicated in dotted outline at 92). Such information might for example a telephone number which the user of the receiver 50 should contact on his being paged.

A modified form of the arrangement shown in Figure 3 is shown in Figure 4 in which it will be seen that the output of the driver amplifier 40 is coupled to both the line and neutral cores of mains cabling indicated generally at 94.

The output of the driver amplifier is fed to the line and neutral course of the cabling 94 via isolating capacitors 96.

In this arrangement driver amplifiers should be earthed and it is possibility desired for this amplifier to be earthed by using earth core of the mains cabling. However it need not be coupled to that earth core but can be earthed in any suitable way.

It will be appreciated that the output of driver amplifier 94 need not be coupled to both the line and neutral cores of the electrical cabling 94 but can, if desired, be coupled to either one of these cores alone.

Advantageously, the output of the transmitter 30 may be coupled to the neutral core of cabling which would allow use of the system across phases within a building or complex of buildings. As shown in Figure 4B, in such an arrangement, the sender 30 is coupled to the neutral point 98 of the three phase supply and, by isolating capacitors 100 to each of the phases 102R, 102Y and 102B as shown.

It will be appreciated that the mains cabling may be replaced with any suitable electrically conductive

medium which can support a standing wave pattern. Metal pipes of a central heating system, for carrying mains water or gas or even structural steel work within a building may be used for this purpose. If these arrangements are used it will be necessary that case be taken that the medium used is not electrically bonded to "earth".

One further element of the system which may necessarily be provided will be a filter provided in the cabling or other electrically conductive medium such as is indicated at 104 in Figure 4A. This is formed to block out unwanted or spurious signals interfering with the data transmission, to comply with possible regulatory requirements and to cope with local conditions as a ground bond or the electrically conductive medium.

The remaining Figures in the Application illustrate highly schematically, three other embodiments within the scope of the present invention.

Figure 5 for example shows an intercom system in which two units 110 and 110' are provided each coupled to an electrically conductive medium 112. Each of the units 110 are similar and incorporate a data sender or transmitter 114 and data receiver 116 coupled to the electrically conductive medium 112. The data sender has associated with it a microphone 118 whilst the data receiver has associated with it a loud speaker 120.

The transmitters and receivers are generally as described above with reference to Figure 3, but they further include means enabling, once a link has been established between two units 110, two-way voice communication to be achieved - the carrier wave signal generated in a sender 114 being amplified or frequency modulated by the output of microphone 118 in known manner and similarly de-modulated by data receiver 116 to provide a signal to a loud speaker 120.

It will be appreciated that there may be a number of units 110 provided in a system embodying the invention

as illustrated in Figure 5, with the data sender of any one of them being operable to apply to the electrically conductive medium 112 an encoded digital data signal allowing that unit 110 to communicate with any one or more of the other units 110'.

It will further be appreciated that variations of the arrangement shown in Figure 5 may provide that a unit 110 incorporates simply a data sender 114 coupled to a microphone in an appropriate matter.

By appropriately encoding the signal applied to the electrically conductive medium 112 it will be possible for a user located at the data sender location to be in one way voice communication with the other units (each including a data receiver and loudspeaker) as desired.

Figure 6, shows another arrangement embodying the invention in which a data sender or transmitter 140 is coupled to an electrically conductive medium 142 (in this case the pipe network of a central heating system). Associated with each radiator 144 coupled to the network 142 there is a valve 146 operable to vary the flow of water from the network 142 to the associated radiator 144.

In this embodiment there is provided associated with each valve 146 a data receiver 148 accessible by the data sender 140 and operable when accessed to vary the setting of the control valve 146 associated with the radiator 144.

In this way it is possible from a single location in the network 142 at which there is a data sender to control the setting of the valves 146 associated with specific radiators 144 in the system. Such an arrangement may be of use, for controlling energy loss in buildings e.g. hotels, offices and the like where it is not necessary to provide heating to unoccupied rooms.

It will be appreciated that variation of the arrangement shown in Figure 6 may be provided to enable lighting control. In such an arrangement a data receiver

would be formed as part of a standard light switch and comprise an isolator, decoder and switching circuit. When the correct code is detected by the data receiver on cabling bringing power to the switch location - having been applied thereto by a centrally located data sender - the unit will switch the associated lamp on (or off) independently of the manual operation of the switch.

In common with the arrangement shown in Figure 6 the signal sender and receivers may be combined in a single unit to allow operation of multiple units of lighting switches from a variety of different locations.

In such an arrangement it is envisaged power for the units of the system would be provided from a separate take off from a ring main.

Again, when considering the application of embodiments of the invention to the control lighting it is envisaged that the system may be used to control security lighting, enabling control of a group of widely spaced security lights spread across a site from a single location, without the need for those lights to be individually wired together for control purposes.

It will be seen that systems embodying the invention obviate the need for complex wiring arrangements (running to and from a central, control, location) commonly used today for controlling actuation of security lighting in response to an alarm indication.

A further system embodying the invention is shown in Figure 7 and comprises a security system. In this arrangement a plurality of units 160 are provided coupled to an electrically conductive medium 162 (which may be mains cabling provided in the location, a gas or pipe network or even, structural steel work, included in the building. Each unit 160 comprises a data sender or transmitter associated with a monitoring device 164 (e.g. a passive infra red detector), in combination with a data receiver. The arrangement further includes a data

sender/receiver 166 having associated with it a display panel 168.

In this embodiment the units 160 are normally be an a quiescent state and provide no output until they are armed or triggered - in response to a signal sent thereto from the unit 166. Thereafter, if the monitoring device 164 associated with any unit 160 detects an intruder, or a fire, it will trigger that unit to pass to the electrically conductive medium 162 an encoded signal detectable by unit 166 and which in response to receipt of the signal will feed an output to the display 168 indicating the location of the unit 160 which has been actuated. The signal sent by any unit 160 will be unique address and code.

Desirably the unit 160 will be built into a lamp housing or light switch plates as the passive infra red detectors 164 will then be at the correct height for effective operation.

In such an arrangement the display 168 will be divided into a number of zones corresponding to the number of units 160 provided in the system.

Signals may be injected into medium 162 by the unit 166 to power the units 160 individually, and the status of each of those units would thereafter be monitored by the unit 166.

An advantage of this arrangement which can readily be seen in that if the units are connected to the neutral core of a mains cable it is possible for the system to work across phases of a mains electrically supply in a large building or group of buildings.

Furthermore, it will be appreciated that power for the system can be taken either from the mains supply or injected into the cabling (e.g. in the case of a power failure) from a battery back-up system provided at the central location where the unit 166 is positioned.

In the arrangement shown in Figure 8 each of a number of individuals located within a building is

provided with a data sender device 180 - the device being substantially as described with reference to Figure 3 and there are provided within the building a number of data receivers 182 coupled by any suitable means (for example electrical mains cabling 184 to a control panel or desk 186 which is provided with means enabling the location of each of the tagged individuals within the building to be monitored.

Another variation is shown in Figure 9 in which individuals within an organisation who are permitted access to a particular facility (e.g. an area or the use of a particular piece of equipment) are provided with a sender 190 (again substantially as described with reference to Figure 3 above) which is worn by the individual which generates an output uniquely identifying the wearer of the sender. The output signal of the sender is detectable by a plate 192 of a data receiver 194 which, in response to reception of an output signal controls operation of a control unit 196 in turn operable to control a lock 198 enabling access to be made to the facility by an authorised individual.

Other modifications may be made to the arrangements described above.

For example the system could be used to monitor the location of an article or an individual within a building. In such cases one would associate with the article or individual a tagging device generating a local, low power radio signal or a capacitive link to effect data transfer. This would be detected by a device associated with a unit, such as a unit 160 as described with reference to Figure 5, and upon such detection the unit 160 would apply to the medium 162 a signal indicating that it had detected the RF or capacitive signal. As this data is received at a central location it would indicate the location of the unit 160 and thus the location of the tagged article or individual within a building could be

monitored from the central location.

It will be appreciated that various other modifications and arrangements may be used without departing from the scope of the invention which provides systems enabling data transmission for information transfer or control purposes which alleviates and/or overcome the limitations of the systems presently known to us.

Industrial Applicability

It will be appreciated the arrangements above described provide useful paging, monitoring, and control systems which may be interconnected by means of mains electrical cabling (and draw power from that cabling) or by any other suitable electrically conductive medium - e.g. gas pipes within a building or even the structural steel work of the building. In such situations the devices may be battery powered or, by means of an appropriate take off, from the mains electrical supply to the building.

CLAIMS

1. A data transfer system comprising at least one data sender electrically coupled or adapted to be coupled to an electrically conductive medium and at least one data receiver, the or each data sender being operable to generate a carrier signal which is modulated by a digital data signal and applied to an electrically conductive medium to which the sender is coupled to generate an electrical capacitive field and the or each data receiver being operable to detect that field, demodulate the signal and in response to the digital data signal effect a control or an information transfer function.

2. A system as claimed in Claim 1, wherein the or each data sender is electrically coupled to a conductive metal plate.

3. A system as claimed in Claim 1, wherein the or each data sender is adapted to be coupled to a pre-existing electrically conductive medium.

4. A system as claimed in any one of claims 1 to 3, wherein the or each data receiver is electrically coupled to an electrically conductive metal detector plate.

5. A system as claimed in any one of claims 1 to 3, wherein the or each data receiver is adapted for electrical coupling to a pre-existing electrical conductive medium.

6. A system as claimed in any one of claims 1 to 5, wherein there is provided a plurality of data receivers, wherein the data sender is operable to modulate said carrier signal with an encoded digital data signal and wherein each data receiver is operable to receive, demodulate and decode the modulated carrier signal so as to enable the data sender to transmit data to said at least one data receiver.

7. A system as claimed in Claim 6, wherein the data sender includes a carrier signal generator and a mixer in which that signal is modulated by a digital data signal from a data signal generator means, the output of the mixer being amplified and passed directly to an electrical conductive medium to which the data sender is coupled.

8. A system as claimed in Claim 6 or Claim 7, wherein the or each data receiver includes a detector plate operable to detect a modulated field generated by the electrical conductive medium coupled to the data sender, and wherein the detector plate generates an output signal in response to the detected field which is amplified and compared with a locally generated carrier signal substantially equivalent to the carrier signal generated in the data sender.

9. A system as claimed in Claim 8, wherein the amplified output of the detector plate of the or each data receiver is passed for comparison via a band pass filter.

10. A system as claimed in Claim 8 or Claim 9, wherein the carrier signal generated in the or each data receiver is passed to a phase shifter generating a pair of outputs each equivalent to the carrier wave generated by the data sender but phase shifted relative to one another.

11. A system as claimed in Claim 10, wherein the outputs of the phase shifter of the or each data receiver are fed as inputs to a pair of mixers each receiving the output of the band pass filter, and wherein the outputs of the mixers are passed by low pass filters to a pair of comparators in which they are compared with reference voltages.

12. A system as claimed in Claim 11, wherein the outputs of the comparators of the or each data receiver are fed to phase detectors in which the digital data applied to the carrier signal in the or each data sender is reconstructed.

13. A system as claimed in Claim 12, wherein the

output of the phase detectors in the or each data receiver is fed to a decoder which in response to a particular encoded signal provides an indication of receipt of the encoded signal.

14. A system as claimed in Claim 13, wherein the or each data receiver is further provided with means allowing the display of information applied to the modulated carrier signal by a data sender.

15. A system as claimed in any one of the preceding claims, for use as a paging system, wherein there are provided a plurality of data receivers each operable to provide a sensible output indication in response to a particular one of a number of different encoded digital data signals used to modulate the output by the data sender.

16. A system as claimed Claim 15, wherein there is provided one data sender and a plurality of data receivers, and wherein the digital data signal from the data sender is operable to effect operation of some or all of the data receivers simultaneously.

17. A system as claimed in any one of claims 1 to 14, for use as a control system, wherein there are provided a plurality of data receivers each operable to effect control of individually associated mechanical device in response to a particular one of a number of different encoded digital data signals used to modulate the output by the data sender.

18. A system as claimed in Claim 17, wherein there is provided one data sender and a plurality of data receivers, and wherein the digital data signal from the data sender is operable to effect control of some or all of the data receivers simultaneously.

19. A system as claimed in Claim 17 or Claim 18, for controlling operation of a hot water radiator heating system, wherein the electrically conductive medium to which the or each data sender and receiver is coupled is formed

by the pipe network of the system, wherein the or each data sender is operable to apply a carrier signal to said pipe network which is modulated by a digital data signal indicative of the temperature required at different locations within the heating system, and wherein each data receiver is operable in response to a received digital data signal to effect alteration of the setting of a valve associated with a radiator of the heating system.

20. A system as claimed in Claim 19, wherein each data receiver is coupled to a valve driver operable to drive an associated valve open or closed in response to a digital data signal received by the data receiver.

21. A system as claimed in Claim 17 or Claim 18, for controlling operation of a lighting circuit, wherein the electrically conductive medium to which the or each data sender and data receiver is coupled comprising the electrical cabling for powering the lighting and each data sender is operable to apply to that cabling signals effective to control operation light sources at various locations in the lighting system, and wherein each data receiver is associated with a switch operable to control one or more light sources, each data receiver being operable in response to a received digital data signal to open or close its associated switch in the lighting circuit.

22. A system as claimed in any one of claims 1, to 14, for use as a monitoring system, comprising in combination at least one first data sender and at least one first data receiver each electrically coupled to the same electrically conductive medium and at locations remote from one another, the or each first data sender generating a carrier signal which is applied to the electrically conductive medium after modulation by digital data signal generated in response to the output of a monitoring device individually associated with the sender, the or each first data receiver being operable to receive the modulated

carrier signal, demodulate that signal and in response to the digital data signal generate an output indicative of the location of the sender and the associated monitoring device.

23. A system as claimed in Claim 22, wherein the or each first data sender is associated with a data receiver and the or each first data receiver is associated with a data sender, the data sender associated with the or each first data receiver being operable to apply to the electrically conductive medium a modulated carrier wave signal receivable by the data receiver associated with the or each first data sender and which in response thereto enables operation of said at least one first data sender.

24. A system as claimed in Claim 22 or Claim 23, wherein said first data receiver has associated therewith a display enabling a visual indication of the location of a first data sender to apply a modulated carrier wave signal to the electrically conductive medium in response to activation of the associated monitoring device.

25. A system as claimed in any one of claims 22 to 24, wherein the monitoring device associated with the or each first data sender comprises a passive infra red device.

26. A system as claimed in any one of claims 22 to 24, wherein the monitoring device associated with the or each of said first data senders comprises a receiver operable to monitor the output of a low power transmitter associated with an article moving through an environment, whereby the position of the article within said environment may be monitored by said at least one first data receiver.

27. A system as claimed in any one of claims 1 to 14, for use as a communication system and comprising at least one data sender electrically couplable to an electrically conductive medium, at least one data receiver electrically couplable to the electrically conductive medium at a location remote from the data sender, the or

each data sender being operable to generate a carrier signal which is modulated by a digital data signal applied to the electrically conductive medium and the or each data receiver being operable to receive the modulated carrier signal, demodulate that signal and in response to a particular data signal enable communication between the data sender and a particular one or more of the data receivers.

28. A system as claimed in Claim 27, wherein the or each data sender further includes a microphone operable to modulate the carrier wave signal applied to the electrically conductive medium and wherein the or each data receiver includes means for demodulating the detected carrier signal and a loud speaker so that voice communication may be established between the data sender and the data receiver.

29. A system as claimed in Claim 28, and wherein each data sender has a data receiver associated therewith and each data receiver has a data sender associated therewith, so that two way voice communication may be established between remote locations.

30. A system as claimed in any one of claims 1 to 14, for use as a security system, wherein the data sender comprises a unit adapted to be worn by an individual and the data receiver unit adapted, in response to a received signal from the data sender, to control operation of a lock enabling access to be made to a facility by an individual wearing the data sender.

31. A data transfer system as claimed in Claim 1, and substantially as herein described with reference to Figures 1 and 2 of the accompanying drawings.

32. A paging system as claimed in Claim 15, and substantially as described with reference to Figures 3 and 4 of the accompanying drawings.

33. A system for controlling operation of a hot water radiator heating system as claimed in Claim 19, and

substantially as described with reference to Figure 6 of the accompanying drawings.

34. A monitoring system as claimed in Claim 22, and substantially as herein described with reference to Figures 7 and 8 of the accompanying drawings.

35. A communication system as claimed in Claim 27, and substantially as herein described with reference to Figure 4 of the accompanying drawings.

36. A security system as claimed in Claim 30, and substantially as herein described with reference to Figure 9 of the accompanying drawings.

FIG. 1

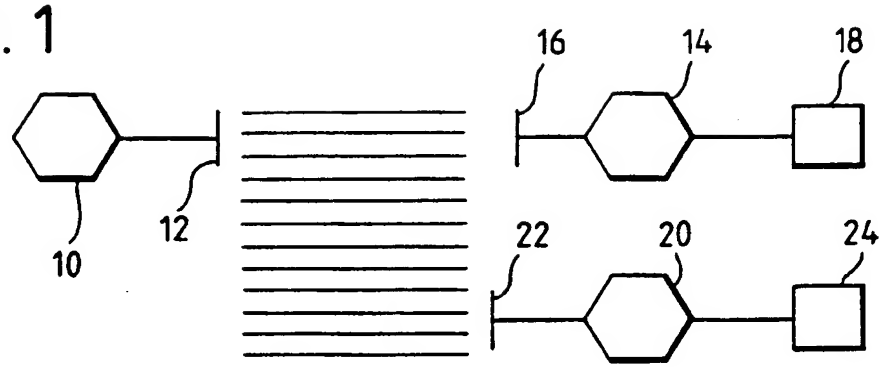
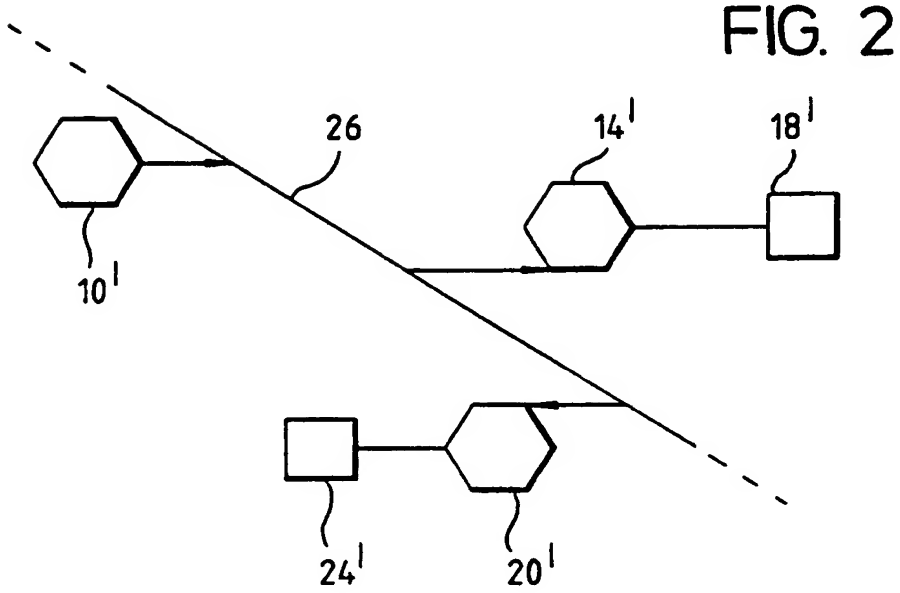


FIG. 2



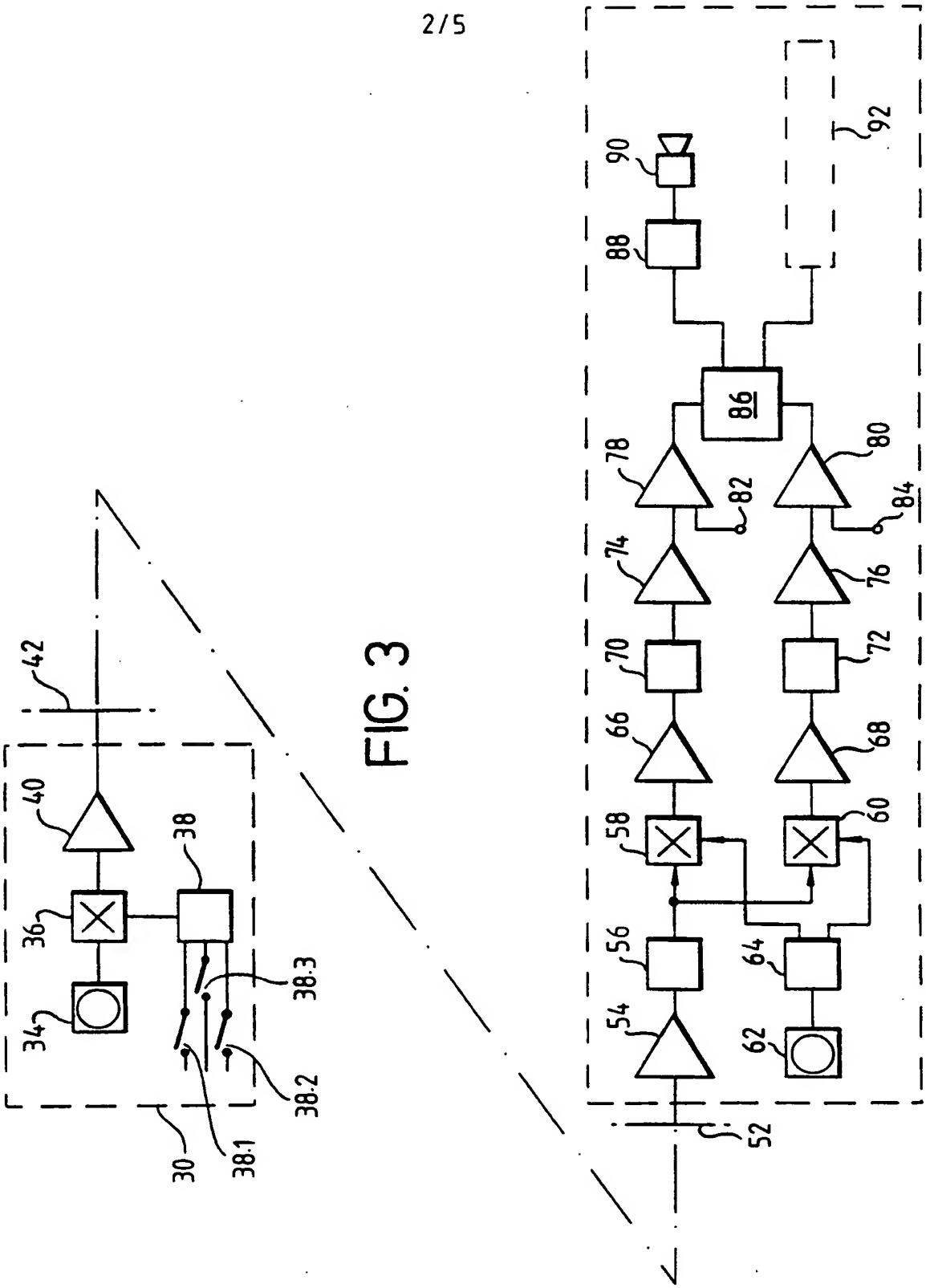

42
40
38
36
34
38.3
38.2
38.1
30
52
54
56
58
60
62
64
66
68
70
72
74
76
78
80
82
84
86
88
90
92

FIG. 3

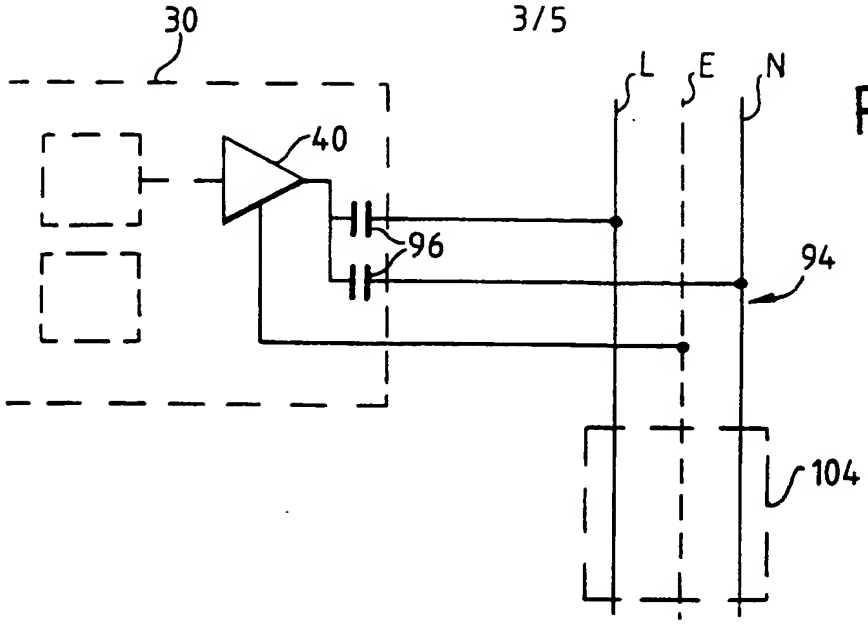


FIG. 4A

FIG. 4B

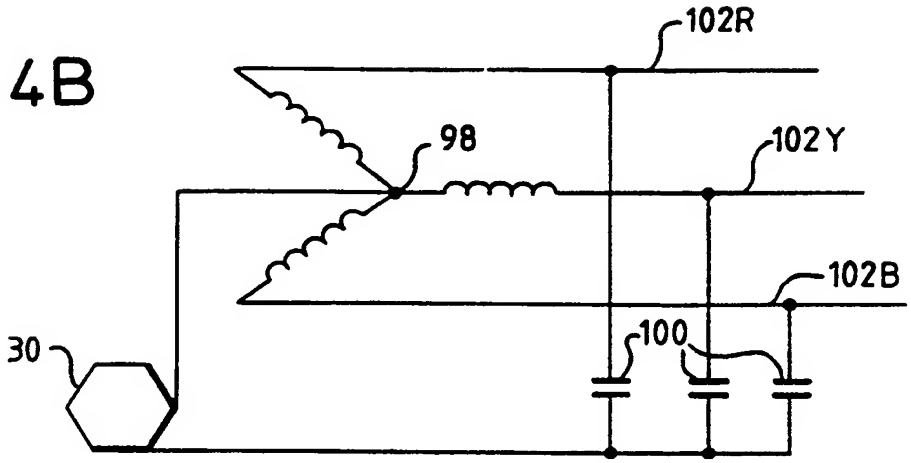


FIG. 9

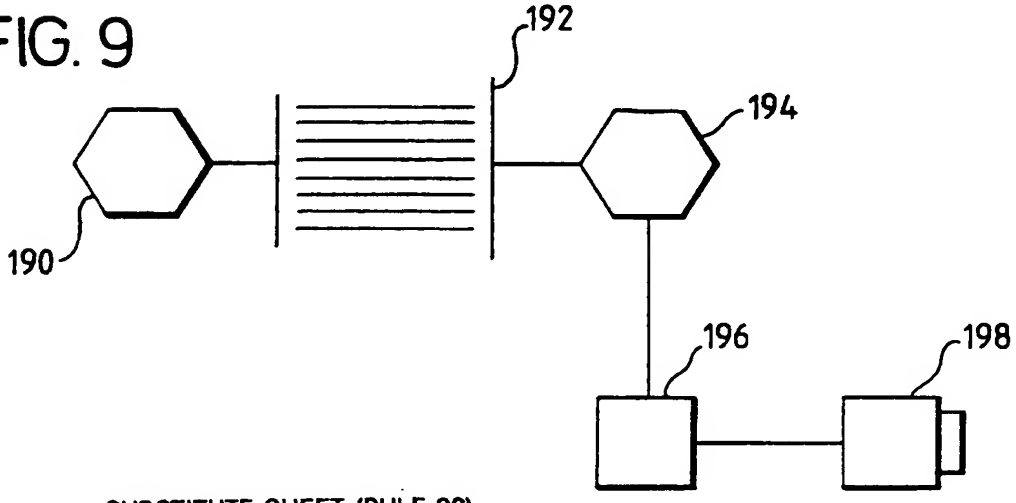


FIG. 5

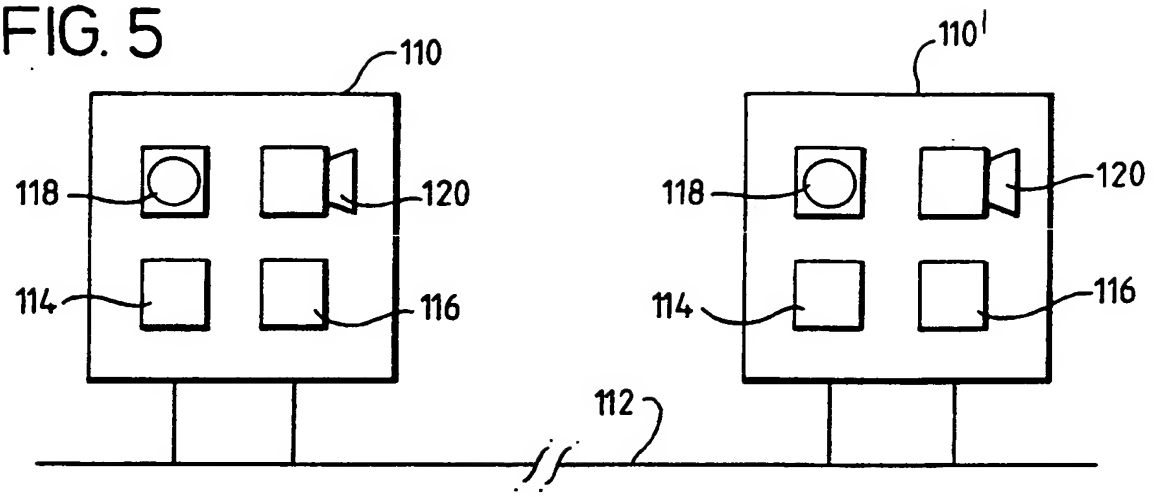

110
110'
118
120
114
116
112
118
120
114
116

FIG. 6

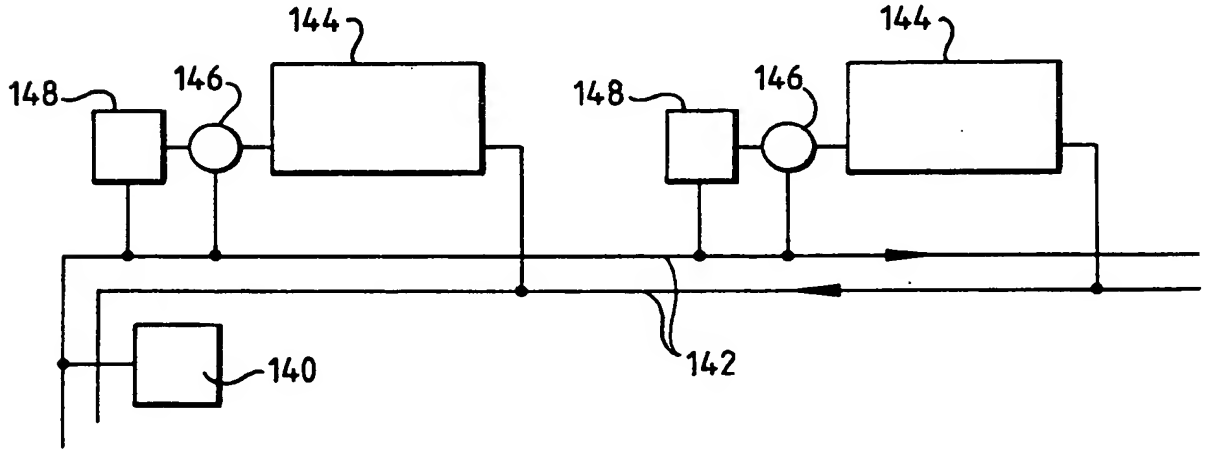

144
146
148
144
146
148
140
142

FIG. 7

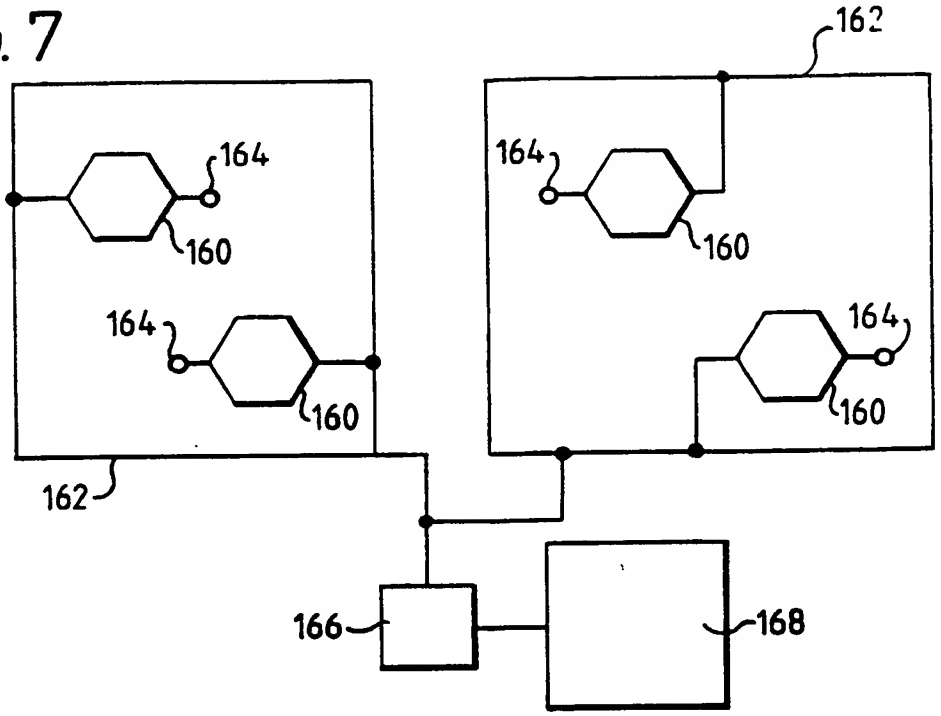
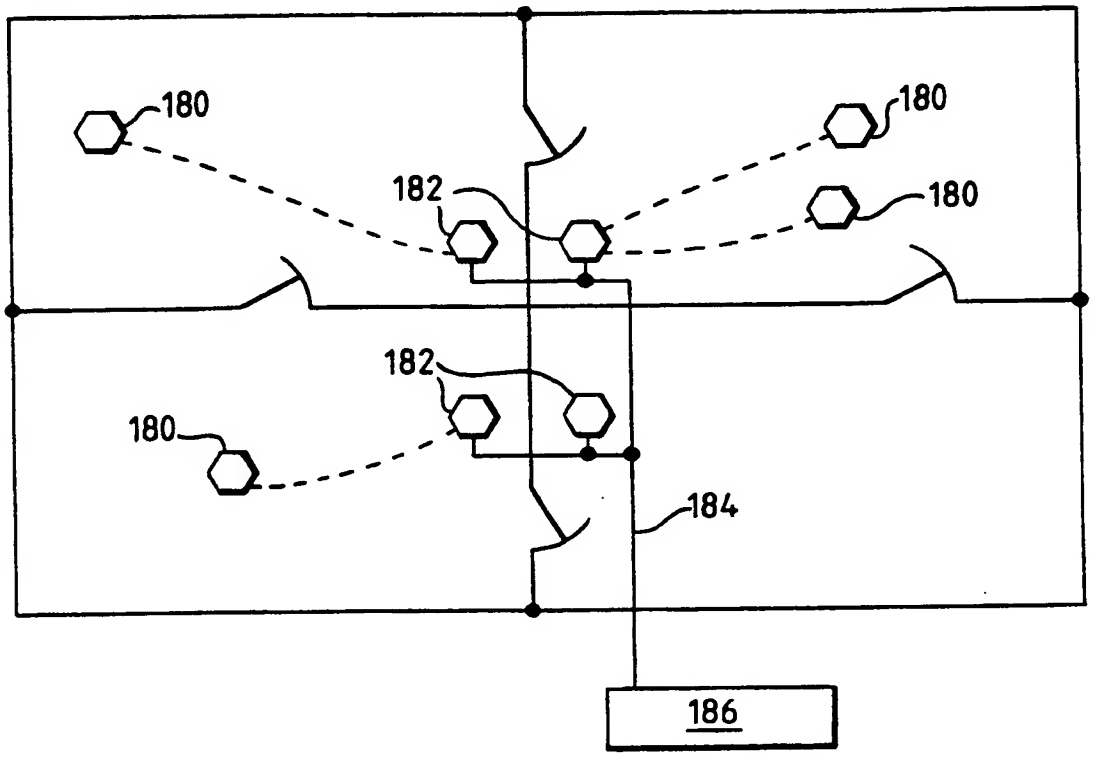

162
164
160
164
160
164
160
164
160
162
166
168

FIG. 8


180
180
182
180
182
180
184
186

THIS PAGE BLANK (USPTO)

THIS PAGE BLANK (USPTO)

DOCKET NO.: 54-02P16362
APPLIC. NO.: PCT/DE2003/003141
APPLICANT: Haby et al.

Lerner and Greenberg, P.A.
P.O. Box 2480
Hollywood, FL 33022
Tel.: (954) 925-1100